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Zooplankton Community Response to Heat Wave 2010 in the Coastal Black Sea Areas: Sevastopol and Varna Bays Case-Studies

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The impact of climate warming on biodiversity was recognised as one of the grand challenges of modern marine ecology. Recently, against the backdrop of a long-term warming trend, extreme regional anomalies of summer temperatures (heat waves) increase in frequency. However, the effect of heat waves on zooplankton communities has not yet been adequately studied.

Summer 2010 was extraordinarily warm in Eastern Europe and large parts of Russia, including the Black Sea coastal area. We analyzed the impact of heat wave events 2010 on crustacean zooplankton based on long-term (2003–2014) routine observations of zooplankton in the Sevastopol Bay (Northern Black Sea) and Varna Bay (Western Black Sea). Changes in the abundance, structure, and seasonal variations of crustacean zooplankton in response to extreme summer temperature were assessed, and indicator species sensitive to positive temperature anomalies were identified.

In the Sevastopol Bay, the highest average annual sea surface temperature (SST) was recorded in 2010 (16.7 °C, with an anomaly of 1.23 °C), and the hottest months were June–September with the maximum SST anomaly in August (28.2 °C, with an anomaly of 2.74 °C). That year, the average abundance of crustaceans reached its maximum values and exceeded 24,000 ind.·m^{-3}, while for 2003–2014, it was on average 9024 ind.·m^{-3}. The main contribution to the total abundance was made by warm water species, namely the copepods *Acartia tonsa*, *Centropages ponticus*, and *Oithona davisae*, and the cladoceran *Penilia avirostris*. Although the seasonal dynamic patterns of the above species were regular within the study period (*O. davisae* and *A. tonsa* peaked in August; *C. ponticus* and *P. avirostris* – in July), the peaks in abundance were more pronounced in 2010.

In the western part of the Black Sea (Varna Bay), the heat wave 2010 was less pronounced. The main feature of the zooplankton response to the heat wave expressed in the increase in the values of the warm water species *A. tonsa*, *C. ponticus*, and *O. davisae* was also noted in Varna Bay. At the same time, there was a remarkable increase in the abundance of the eurythermal species *A. clausi*.

We have shown that positive temperature anomalies led to a sharp increase in the abundance of warm water crustacean species and their share in the zooplankton community. Apparently, extreme temperature increase led to a reduction of generation length of the warm water species, resulting in a sharp increase in their abundance. Thus, these species should be considered as indicators of climate warming events. A shift in the zooplankton communities in response to extreme summer temperatures could help to reveal the climate warming effect on zooplankton and marine ecosystems as a whole in the future.

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